Homeownership and the life cycle: an ordered logit approach*

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Abstract

This paper presents an ordered logit approach to model the optimal timing of buying a house in the life cycle. The model is applied to three recent Belgian household budget surveys. We find that households postpone homeownership or choose to be lifelong tenant due to an increase of the transaction tax rate, the real interest rate on mortgages and an indicator for the evolution of real house prices. Expenditures on nondurables, on the contrary, have a positive impact on (early) homeownership.

Key words: homeownership, life cycle, transaction tax.
JEL-classification: D12, R21.

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1 Introduction

The transaction taxes associated with buying a house are relatively high in the different Belgian regions. In Flanders, for example, the basic rate of the registration fee equals 10 percent of the sales price, if the house is purchased on the secondary market. If the house is bought on the primary market, then there is an indirect tax of 21 percent. Moreover, these taxes form only part of the total transaction costs which include search and negotiation costs and intermediation fees.[1,2] As a consequence, such taxes and other transaction costs potentially play an important role in the tenure choice of households.

The choice problem between renting and owning a house is both theoretically and empirically well documented. Empirical studies on tenure choice mainly concentrate on this dichotomous choice between renting and owning, taking into account demographic characteristics and economic explanatory variables like (permanent) income and measures of borrowing constraints (see, *e.g.*, King, 1980, Gyourko and Linneman, 1997 and Haurin *et al.*, 1997).

In this study, we present an alternative approach to model tenure choice. Rather than focusing on the above dichotomous choice, we model the moment in the life cycle that a household becomes homeowner. This is done by means of an ordered logit model.[3] The discrete outcomes in the model consist of the moments in the life cycle at which an individual may purchase a dwelling. An individual can, for example, become a homeowner before the age of 30, between the age of 30 and 40, *etc.*[4] The last choice category consists of people for whom it is never optimal to buy a house to live in (life long tenants). Empirically, these are people who turn out to be (still) tenant at the age of 70 or older.

We posit that the transaction tax rate has a considerable impact on the timing of homeownership. More specifically, we expect that if the transaction tax rate is higher, then the purchase of a house will be postponed to a later moment in the life cycle. This can be embedded in theory as follows (see, *e.g.*, Goodman, 1995, or Bar-Ilan and Blinder, 1988). When choosing between renting and owning, a tenant household compares the respective user costs for a given amount of housing services. The user cost of owner-occupied houses is affected positively by the real interest rate on mortgages and negatively by the evolution of real house prices (see Dougherty and Van Order, 1982). Because of income tax advantages associated with financing house purchases, the user cost of owner-occupied housing may be lower than the rent a tenant pays. However, these advantages should be high enough to counterbalance the transaction costs associated with switching from the rental market to becoming a house-owner. Next to transaction taxes, other explanatory variables like demographic char-

[1] The housing market is far from perfect; e.g. many information costs are involved.

[2] In Belgium the intervention of a notary is legally compulsory.

[3] A somewhat related approach can be found in Guiso and Jappelli (2002). They study the effects of private transfers and borrowing constraints on the timing of homeownership via a survival analysis, where buying a house is considered as a 'failure' (namely, the 'failure' to survive in the rental market).

[4] Of course, we also deal with households consisting of several individuals. Age then refers to the age of the head of the family.

acteristics and economic variables may affect the timing of homeownership. A higher permanent income, for example, increases own funds, which make it possible to pay the downpayment and to decrease the time necessary to save the downpayment.[5]

The ordered logit model is applied to data that are drawn from the 1997-1998, 1999 and 2000 Belgian household budget surveys. The sample selection is for homeowners who purchased their house after 1952 and for tenants who are older than 70 years; the latter thus chose the last outcome of the ordered logit model; these are people who stay renter during their whole life.

The remainder of the paper is structured as follows. Section 2 goes further into the ordered logit approach to tenure choice. In Section 3, we discuss the data. Empirical results are presented in Section 4. Section 5 concludes.

2 Homeownership and the life cycle

In the empirical application, we will consider six outcomes with respect to the moment in the life cycle that a household becomes homeowner. The different outcomes are clearly ranked: a household may become homeowner before the age of 30, between the age of 30 and 40, between the age of 40 and 50, between the age of 50 and 60, between the age of 60 and 70 or prefer to stay renter during the whole life cycle. Assuming that people who report to be tenant at the end of the life cycle (at an age of 70 or higher) have never been house-owner before, this observed category comprises (part of) the lifelong tenants.[6] Because of the inherent ordering of the different outcomes, we can make use of an *ordered logit model* to analyse the timing of homeownership (Walker and Duncan, 1967, also Greene, 2003).

To see this, consider the following latent regression:

$$y_i^* = \mathbf{x}_i'\boldsymbol{\beta} + \varepsilon_i, \tag{1}$$

where y_i^* is an unobserved latent variable, reflecting the global transaction cost for household i, expressed in terms of utility, to switch from the rental market to homeownership, including subjective evaluations of information costs. The vector $\boldsymbol{\beta}$ is a vector of unknown parameters converting the vector of explanatory variables $\mathbf{x}_i$ into their contribution to the utility cost of transaction costs. The variable ε_i is an unobserved disturbance term reflecting stochastic preference

[5] In Belgium credit rationing is usually based on the current income position of the candidate borrower. Legally, there is no downpayment *ratio* but interests increase prohibitively large if one wants to borrow more than 80% of the house value. This formally almost coincides with a downpayment constraint.

[6] Our dataset does not allow to identify tenants who once owned a house or owners who purchased and sold a house in the past. This problem is negligible, though, since the mobility with respect to own houses is very low in Belgium. Only in the last stage in the life cycle, households often sell the own house and move into an old people's home. This feature is not a problem in our application, since people who live in so-called collective households are not taken up in household budget surveys. On the other hand, almost no households became house-owner after the age of 70. These few observations were omitted for the analysis.

differences between households, not controlled for. This variable is assumed to be logistically distributed, *i.e.* $F(\varepsilon_i) = \frac{1}{1+e^{-\varepsilon_i}}$. The higher the transaction cost, the longer it will last until the household will buy a house. This can be understood as follows. Let μ_k reflect the expected utility gain from switching to homeownership during the k-th period of the life cycle, measured at time k (for $1 \leq k \leq 5$, for the last period in the life cycle, $k = 6$, only lifelong tenants being selected). It is natural to assume that this gain increases over time: firstly, the household succeeded to save money during a longer time period, so that the portion of the house that should be debt-financed declines, when buying later in the life cycle. Secondly, buying a house entails a *lock-in* cost, caused by the impossibility of adapting the house to changing housing needs during the life cycle without bearing new transaction costs.[7] The relation between the unobserved y_i^* and the observed outcome for household i, y_i ($y_i = 1, 2, ..., 6$), can be summarized as follows:

$$\begin{aligned} y_i &= 1 \text{ if } y_i^* \leq \mu_1, \\ &= 2 \text{ if } \mu_1 < y_i^* \leq \mu_2 \\ &= 3 \text{ if } \mu_2 < y_i^* \leq \mu_3 \\ &\quad ... \\ &= 6 \text{ if } \mu_5 \leq y_i^*. \end{aligned} \tag{2}$$

In words, if the expected utility gain of switching to homeownership at time k exceeds the transaction cost, then the household will buy during period k. In fact, the μ's are those unknown utility gains to be estimated. These μ's must satisfy $\mu_1 < \mu_2 < ... < \mu_5$. For the discounted utility gains, though, we assumed that the net utility gain of a later period will never exceed the net gain of buying one period earlier. If this were not the case, then every household would keep on postponing homeownership and remain lifelong tenant. The probability that household i becomes homeowner between the age of 40 and 50 ($y_i = 3$) is thus equal to the probability that the latent variable y_i^* is between μ_2 and μ_3. Since we assume that the disturbance terms are logistically distributed, we obtain the

[7] While renting, moving also bears a transaction cost (search and information costs) but this cost is much lower than in case of buying a new house.

following probabilities:

$$\begin{aligned}
\Pr(y_i = 1) &= \Pr(\mathbf{x}_i'\boldsymbol{\beta} + \varepsilon_i \leq \mu_1) = \frac{1}{1+\exp(\mathbf{x}_i'\boldsymbol{\beta} - \mu_1)}, \\
\Pr(y_i = 2) &= \Pr(\mathbf{x}_i'\boldsymbol{\beta} + \varepsilon_i \leq \mu_2) - \Pr(\mathbf{x}_i'\boldsymbol{\beta} + \varepsilon_i \leq \mu_1) \\
&= \frac{1}{1+\exp(\mathbf{x}_i'\boldsymbol{\beta} - \mu_2)} - \frac{1}{1+\exp(\mathbf{x}_i'\boldsymbol{\beta} - \mu_1)}, \\
\Pr(y_i = 3) &= \Pr(\mathbf{x}_i'\boldsymbol{\beta} + \varepsilon_i \leq \mu_3) - \Pr(\mathbf{x}_i'\boldsymbol{\beta} + \varepsilon_i \leq \mu_2) \\
&= \frac{1}{1+\exp(\mathbf{x}_i'\boldsymbol{\beta} - \mu_3)} - \frac{1}{1+\exp(\mathbf{x}_i'\boldsymbol{\beta} - \mu_2)}, \\
&\cdots \\
\Pr(y_i = 6) &= \Pr(\mu_5 \leq \mathbf{x}_i'\boldsymbol{\beta} + \varepsilon_i) \\
&= 1 - \frac{1}{1+\exp(\mathbf{x}_i'\boldsymbol{\beta} - \mu_5)}.
\end{aligned} \tag{3}$$

The derived logit model could also be interpreted independently from the latent variable equation (1), explaining the motives behind the optimal moment in the life cycle of purchasing a house, as a reduced form modelling the influence of the $\mathbf{x}_i$ variables on the probability to buy a house at a certain moment in the life cycle. It is precisely these reduced form effects that will be of interest in the empirical exercise below. The estimation of the unknown coefficients $\boldsymbol{\beta}$ and thresholds μ can be done numerically by means of the method of maximum likelihood, where the above probabilities are the elements of the likelihood function. It is clear from equation (1), that the probability that homeownership is postponed increases, if β_j is positive and the corresponding explanatory variable x_i^j increases. This can be seen more formally by calculating the derivatives of the cumulative probabilities:

$$\frac{\partial \Pr(y_i \leq k)}{\partial x_i^j} = -\beta_j \frac{\exp(\mathbf{x}_i'\boldsymbol{\beta} - \mu_k)}{(1+\exp(\mathbf{x}_i'\boldsymbol{\beta} - \mu_k))^2}, \tag{4}$$

where $\Pr(y_i \leq k) = \frac{1}{1+\exp(\mathbf{x}_i'\boldsymbol{\beta} - \mu_k)}$. This confirms that the probability of buying earlier than time k in the life cycle decreases with an increase in any of the explanatory variables, say j, if β_j is positive, and the other way around if $\beta_j \leq 0$.

However, coefficients of this kind of models are to be interpreted carefully. Marginal effects associated with the probability that one becomes homeowner in the kth stage of the life cycle are as follows:

$$\frac{\partial \Pr(y_i = k)}{\partial x_i^j} = -\beta_j \left(\frac{\exp(\mathbf{x}_i'\boldsymbol{\beta} - \mu_k)}{(1+\exp(\mathbf{x}_i'\boldsymbol{\beta} - \mu_k))^2} - \frac{\exp(\mathbf{x}_i'\boldsymbol{\beta} - \mu_{k-1})}{(1+\exp(\mathbf{x}_i'\boldsymbol{\beta} - \mu_{k-1}))^2} \right), \tag{5}$$

where $\mu_0 = -\infty$ and $\mu_6 = \infty$. Clearly, unambiguous statements on the basis of the sign of the estimated coefficients $\boldsymbol{\beta}$ can only be made with respect to both

boundary probabilities $\Pr(y_i = 1)$, the cumulative probabilities $\Pr(y_i \leq k)$ and $\Pr(y_i = 6) = 1 - \Pr(y_i \leq 5)$. The sign of the estimated coefficients is less informative for the marginal effects associated with the other probabilities.

3 Data

The data used in this study are drawn from the budget surveys of 1997-1998, 1999 and 2000 of the Belgian National Statistics Institute. Apart from expenditures, incomes and demographic variables, the surveys contain information on whether a household owns or rents the house in which it lives. For homeowners, also the year of purchase of this house is available. These survey data were complemented with macroeconomic variables like the interest rate on mortgages, coming from the National Bank of Belgium, and a regionally differentiated indicator for the evolution of house prices through time.[8] The price indicator and nominal interest rates were deflated by the consumer price index in the empirical exercise (see Dougherty and Van Order, 1982).

The sample that is used in the empirical exercise consists of tenants who were older than 70 years and homeowners. Since the house price indicator only goes back to 1953, homeowners who purchased their house before 1953 were also excluded. This finally results in a sample of 6635 households.

Table 1 gives some summary statistics on the selected sample. Monetary variables are expressed in year 2000 euros. The transaction tax rate, real interest rate on mortgages and the regional house price indicator are those of the year of purchase of the house for homeowners. For tenants, these variables are those for the year in which they participated in the survey. Note that not all demographic variables in the table are adequate for the empirical exercise. Family size and number of children, for example, are associated with the household's situation at the time of participation to the budget survey. Of course, these variables do not necessarily correspond to the household's structure at the time of purchasing the house and, therefore, will not be included in the analysis below. Other demographic variables like level of education or region are less vulnerable to this problem.[9] In order to take account of a similar problem with respect to income, we will use nondurable expenditures as a proxy for permanent income in the empirical exercise.[10]

Figure 1 presents the timing of homeownership for the selected sample. As is clear from the figure, 71% of the households have purchased their house before the age of 40. The greater part of this group became homeowner between the age of 30 and 40. As could be expected, the numbers of households that purchase

[8] In Belgium, no index for house prices is available. We drew the data from a weighted average of sold houses, provided by STADIM, a real estate study group.

[9] Movements between two regions are rather rare in Belgium because of the different languages used.

[10] Note that this variable is not independent from the household structure at the time of the survey. We believe, however, that it reveals enough information on a household's life time income.

an own house in later stages of the life cycle are much lower. Finally, some 6% of the households turn out to be lifelong tenants.

Table 1: Descriptive statistics (6635 obs.)

Variable	Mean	Std.dev.
Age head of the family	53.10	14.90
Dummy for female head of the family	0.25	0.44
Family size	1.99	0.91
Number of children	0.91	1.17
Number of employed	1.04	0.91
Dummy for Flemish Region	0.51	0.50
Dummy for Walloon Region	0.36	0.48
Dummy for lower secondary school	0.22	0.42
Dummy for higher secondary school	0.26	0.44
Dummy for non-academic higher education	0.20	0.40
Dummy for academic higher education	0.10	0.30
Nondurable expenditures	26814.27	13199.10
Income	34839.33	26095.33
Transaction tax rate	0.11	0.05
Regional house price indicator	2.23	0.53
Real interest rate on mortgages	0.047	0.026

Notes: Brussels Capital Region is reference category for regional dummies. Primary school is reference category for education dummies. Monetary values are in year 2000 euros. Regional house price index (deflated by consumer price index) = 1 in 1953.

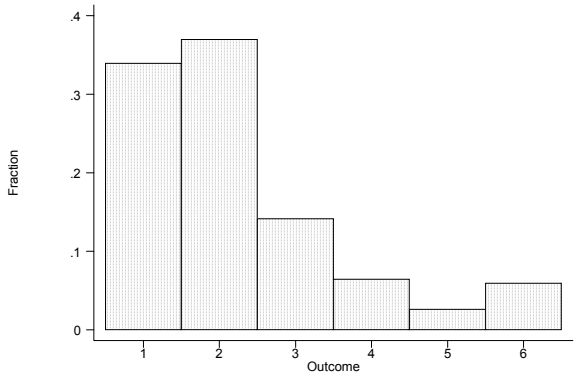

Figure 1: Timing of homeownership

4 Empirical results

Table 2 reports the results of the ordered logit estimation of the timing of homeownership. All explanatory variables are significantly estimated at the 5% significance level. As remarked earlier, the signs of the estimated coefficients are only directly informative for the probabilities associated with the first (homeowner before the age of 30), the last choice outcome (lifelong tenant) and the cumulative probabilities. It is easily seen from equation (5) that a negative coefficient implies that the probability of purchasing a dwelling before the age of 30 and/or earlier in the life cycle increases, if there is an increase in the corresponding explanatory variable. Alternatively, the probability of being a lifelong tenant decreases if there is an increase of the explanatory variables with a negative coefficient.

It is clear from the table that, ceteris paribus, the probability of becoming homeowner (before the age of 30) is higher for households with a higher level of nondurable expenditures (as a proxy for permanent income). In line with the underlying decision model, the probability of purchasing an own house decreases if the transaction tax rate is increased. Otherwise said, the probability of lifelong tenancy increases with the transaction tax rate. The same applies to the regional house price indicator: the higher this index, the lower the probability of homeownership. Also the coefficient associated with the real interest rate on mortgages has the expected sign: the higher the interest rate, the greater the probability of lifelong tenancy and the smaller the probability of becoming homeowner (before the age of 30).

Table 2: Ordered logit estimation results of timing homeownership

Variable	Coefficient	Standard error
Nondurable expenditures (in 1000 euro)	-0.024	0.002
Dummy for female head of the family	0.286	0.054
Dummy for Flemish Region	-1.311	0.074
Dummy for Walloon Region	-0.884	0.075
Dummy for lower secondary school	-0.764	0.070
Dummy for higher secondary school	-1.039	0.070
Dummy for non-academic higher education	-0.887	0.076
Dummy for academic higher education	-0.680	0.093
Transaction tax rate	2.843	0.513
Regional house price indicator	1.013	0.046
Real interest rate on mortgages	2.192	0.877
μ_1	-0.082	0.159
μ_2	1.642	0.160
μ_3	2.600	0.162
μ_4	3.320	0.165
μ_5	3.776	0.168
Log likelihood	-9052.07	

Notes: Brussels Capital Region is reference category for regional dummies. Primary school is reference category for education dummies.

In order to be able to derive more information from the estimated coefficients, Table 3 presents the derivatives of the six probabilities for a selection of important explanatory variables. These derivatives are calculated at the sample means of the independent variables. It is clear from the table that a marginal increase in nondurable expenditures increases the probability of becoming homeowner before the age of 30, while it decreases all the other probabilities. We see the reverse picture for the transaction tax rate: a marginal increase in this rate decreases the probability of purchasing an own house before the age of 30, but increases the probabilities associated with the other choice outcomes. A lower probability to buy before the age of 30 implies also that the probability of lifelong tenancy increases if the transaction tax rate increases. Note that the probability mass that is shifted from the first outcome is unequally divided between the other outcomes: the probability of becoming homeowner between the age of 40 and 50 ($\Pr(y_i = 3)$) is mostly affected. As indicated earlier, also marginal increases of the house price indicator and the interest rate on mortgages have a negative effect on the probability of purchasing an own house (before the age of 30). Again, the probability of becoming homeowner between the age of 40 and 50 is increased mostly by the above marginal changes.

Table 3: Marginal effects

	$\frac{\partial \Pr(y_i=1)}{\partial x_i^j}$	$\frac{\partial \Pr(y_i=2)}{\partial x_i^j}$	$\frac{\partial \Pr(y_i=3)}{\partial x_i^j}$	$\frac{\partial \Pr(y_i=4)}{\partial x_i^j}$	$\frac{\partial \Pr(y_i=5)}{\partial x_i^j}$	$\frac{\partial \Pr(y_i=6)}{\partial x_i^j}$
Nondur. exp.	0.005	-0.000	-0.002	-0.001	-0.001	-0.001
	(0.00)	(0.04)	(0.00)	(0.00)	(0.00)	(0.00)
Trans. tax rate	-0.605	0.023	0.252	0.145	0.062	0.123
	(0.00)	(0.06)	(0.00)	(0.00)	(0.00)	(0.00)
House price indicator	-0.215	0.008	0.090	0.051	0.022	0.044
	(0.00)	(0.04)	(0.00)	(0.00)	(0.00)	(0.00)
Real interest rate	-0.466	0.018	0.195	0.111	0.047	0.095
	(0.01)	(0.12)	(0.01)	(0.01)	(0.01)	(0.01)

Note: P-values are between brackets.

As a final exercise, we present the goodness-of-fit of our model by means of a 'hits and misses' table. The prediction rule is that a household is located in the choice outcome with the highest probability, as calculated by the estimates. Table 4 shows that the predicted outcome corresponds with the observed one for 2619 (or 39.47%) of the households in the sample (see diagonal of the table). This seems to be a fairly good result: a rule which assigns all households to the outcome with the highest number of observations (outcome 2), would correctly predict 36.97% of the outcomes. However, such rule misses a great deal of what is observed in reality. Our model is able to correctly predict other choice outcomes, like the probability of lifelong tenancy, as well.

Table 4: Prediction results

	1	2	3	4	5	6	Total
1	973	1272	1	0	0	6	2252
2	934	1505	1	0	0	13	2453
3	257	658	2	0	0	22	939
4	73	344	3	0	0	6	426
5	25	144	0	0	0	4	173
6	0	240	13	0	0	139	392
Total	2262	4163	20	0	0	190	6635

Note: Rows are observed outcomes, columns predicted outcomes.

5 Conclusion

In this paper, we have presented an ordered logit approach to model the optimal moment in the life cycle to buy a living dwell. Rather than concentrating on the dichotomous choice between owning and renting a house, we thus focused on the moment in the life cycle that a household becomes homeowner. The model was applied to data drawn from three recent Belgian household budget surveys that contain information on the tenure choice of households. Crucial to our application, the surveys also contain information on the year of purchase of the own house for owners.

Our empirical results indicate that the transaction tax rate, which is relatively high in the different Belgian regions, has a negative impact on (early) homeownership. The higher this tax rate, the more households postpone homeownership or choose to be lifelong tenants. Also real house prices and the interest rate on mortgages have a negative impact on (early) homeownership. In contrast with the former, higher expenditures on nondurables (that can be seen as a proxy for permanent income) imply a higher probability of becoming homeowner; and more specifically homeownership before the age of 30.

A possible avenue for future research may be the comparison of the results obtained by our model with those obtained by the approach followed by Guiso and Jappelli (2002). They modelled the timing of homeownership by means of a survival analysis where the purchase of an own house is considered as a 'failure' (to survive in the rental market). The latter approach has the advantage that it makes use of more information than our model (namely, observations stemming from households that are tenants in earlier stages of the life cycle). Unfortunately, this method could not be applied to our data set, since we do not observe the (truncated) time spells during which households are renters.

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